BELLCOMM, INC.
1100 Seventeenth Street, N.W. Washington, D. C. 20036

SUBJECT: Use of Aluminum Wire on AAP as a Weight Saving Measure Case 620

DATE: October 18, 1968

FROM: B. W. Moss

MEMORANDUM FOR FILE

Substitution of aluminum wire for copper wire wherever possible in the various AAP modules could result in weight saving of a few hundred pounds. If we compare aluminum and copper as electrical conductors, we find respective resistivities of 2.828 and 1.724 microohm per cm cube @ 20°C. From this, we see that an aluminum conductor must have a cross sectional area of 1.640 times copper for the same line resistance. This corresponds to a diameter increase of 1.281 times the diameter of an equivalent copper conductor.

The density of aluminum is 2.699 gms per cm^3 and of copper 8.89 gms per cm^3. While 1.640 times as much aluminum would be required, its lower density would result in an equivalent aluminum conductor weighing 0.498 times the copper conductor.

The insulation on conductors for general purpose aerospace applications is approximately 0.25 times the weight of the conductor, for sizes in the range of 6 AWG to 14 AWG. The larger diameter aluminum conductor will require 1.281 times as much insulation which, related to a copper conductor would be 0.320 times the copper conductor weight.

Thus, an aluminum conductor with insulation should weigh 0.818 times a bare copper conductor and an insulated copper conductor should weigh 1.25 times a bare conductor. So, the ratio of aluminum finished conductor weight to copper finished conductor weight is 0.6544. Table I shows the comparison between copper and aluminum insulated wire for equivalent line resistance. Both wires have the same type of insulation and both have stranded conductors. As the wire size gets smaller, the insulation becomes a larger percentage of the finished wire weight, and the advantage of aluminum over copper decreases. For example, the ratio of aluminum finished conductor to copper finished conductor weight for 10 AWG copper and 8 AWG aluminum is 0.695 while for 22 AWG copper and 20 AWG aluminum, the ratio would be 0.9545.

(NASA-CR-73569) USE OF ALUMINUM WIRE ON AAP AS A WEIGHT SAVING MEASURE (Bellcomm, Inc.) 3 p

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(NASA CR OR TMX OR AD NUMBER) (CATEGORY)

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The use of aluminum conductors poses some problems that are serious although relatively easily handled. Aluminum and copper are not compatible from an electrolytic corrosion point of view so that special corrosion barrier coatings must be used wherever copper (or copper bearing alloys such as phosphor bronze) and aluminum interface as in connectors. Aluminum is not readily soldered for electrical connections without special solders and fluxes with which many technicians are unfamiliar and for which they are not qualified.

The substitution of aluminum wire for copper could require design and qualification of a complete new line of connectors and terminal devices. In addition, since the size of each conductor must be increased, the size of multi-conductor cables and wire bundles, will also grow significantly resulting in increased volume requirements for interconnection wiring.

The electrical wiring weight, while large, is a miniscule portion of the total vehicle weight. Even a reduction in the wiring weight of as much as 30% would be achieved at a significant cost in procurement and requalification of wire, connectors, and wiring devices.

B. W. Moss

1022-BWM-ep B. W. Moss

Attachment
Table I

BELLCOMM, INC.

Subject: Use of Aluminum Wire on AAP as a Weight Saving Measure - Case 620

From: B. W. Moss

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Table I

Copper					Equivalent Aluminum					
AWG	Con-duct. Diam.	Cross Sect. Circ. Mils	per M ft. ohms	per M ft. lbs.	AWG	Con-duct. Diam.	Cross Sect. Circ. Mils	per M ft. ohms	per M ft. lbs.	wgt. alum. / wgt. copper
10	0.124	10443	1.10	40.3	8	0.160	16564	1.093	28.0	0.695
8	0.158	16864	0.70	63.0	6	0.211	28280	0.641	48.0	0.762
6	0.198	26813	0.436	103.0	4	0.262	42420	0.427	65.C	0.631
4	0.249	42613	0.274	159.0	2	0.330	67872	0.268	94.0	0.591
2	0.321	66832	0.179	243.0	0	0.418	107464	0.169	137.0	0.564